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PROBLEMS.

38. Proposed by L. B. FILLMAN, St. Petersburg, Pennsylvania.

The diameter of the circular base of a dome is $10=a$ feet, which is also the distance from any point on the circumference of the base to any point on the opposite side of the dome from base to apex. Find volume of dome. [See Prob. 21.—EDITOR.].

39. Proposed by J. C. GREGG, Brazil, Indiana.

Show that the curve

$$x=9a\sin\theta-4a\sin^2\theta$$
$$y=-3a\cos\theta+4a\cos^2\theta$$

is symmetrical to the axes, and has double points and cusps: find the lengths of the arcs, (*a*) between the double points, (*b*) between a double point and a cusp, (*c*) and the arc connecting two cusps and not passing through a double point. [*Rice and Johnson's Integ. Cal.* (abridged), p. 176.]

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MECHANICS.

Conducted by B.F.FINKEL, Kidder, Missouri. All Contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

15. Proposed by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in New Windsor College, New Windsor, Maryland.

Show that the *eastward deviation* of bodies falling from a great height is

$$E_a=\frac{4\pi t(H-\frac{1}{2}\triangle)\cos\phi}{3T}.$$

II. Solution by Professor G. B. M. ZERR, A. M., Principal of High School Staunton, Virginia.

Let OZ be the axis of z, OX, the axis x, OY, the axis of y.

Let ϕ=the latitude of O,

β=angular velocity of the earth around DO,

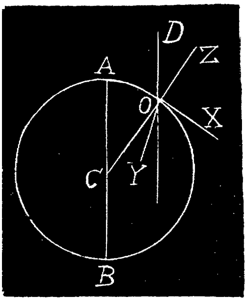
$\triangle$=excess of descent in vacuo over that of air,

T=time in seconds of siderial day,

H=height of body above the earth.

Also let OX be tangent to the meridian and OY perpendicular to it, and their positive directions respectively south and west. The velocity of the body eastward at the moment it is dropped from z, $=\beta H\cos\phi$. Now if gravity did not alter its direction, owing to the rotation of the earth, the body would describe a parabola and the easterly deviation would be $(\beta H\cos\phi)t$, where t=time of falling. But the rotation β about OD is equivalent to $\beta\sin\phi$ about

OZ, and $\beta \cos\phi$ about OX. The former does not alter the position of OC, while the latter turns OC in a time t through an angle $\beta \cos\phi t$. Hence the body is acted upon by a westerly component, due to the change of direction of gravity, $=g \sin(\beta \cos\phi t)=g\, \beta \cos\phi t$, since βt is small. Now let y be the distance the body is in space from the plane XZ at the moment the body begins to fall, and then the equation of motion of the body in space is $\frac{d^2y}{dt^2}=g\, \beta\, t \cos\phi$. Integrating this, and remembering that, as explained above, $\frac{dy}{dt}=-\beta H \cos\phi$, we get $y=-\beta H t \cos\phi+\frac{1}{6} g\beta t^3 \cos\phi$. $\therefore$ $E_d=\beta t \cos\phi(H-\frac{1}{6} gt^2)$. But $\frac{1}{2} gt^2=H+\triangle$ and the centrifugal force at the equator $=\beta^2 r=\frac{4\pi^2 r}{T^2}$, where r = radius of the earth.



$$\therefore \quad \beta^2=\frac{4\pi^2}{T^2} \text{ and } \beta=\frac{2\pi}{T}. \text{ Substituting we get}$$

$$E_d=\frac{2\pi t \cos\phi}{T}\left\{ H-\tfrac{1}{3}(H+\triangle) \right\}=\frac{2\pi t \cos\phi}{T}(\tfrac{2}{3}H-\tfrac{1}{3}\triangle)$$

$$=\frac{2\pi t \cos\phi}{3T}(2H-\triangle)=\frac{4\pi t(H-\frac{1}{2}\triangle) \cos\phi}{3T}.$$

[NOTE.—No solution has yet been received to problem 17. EDITOR.]

PROBLEMS.

24. Proposed by Professor J. F. W. SCHEFFER, A. M., Hagerstown, Maryland.

A sphere whose center of gravity does not coincide with its geometrical center is placed on a rough inclined plane. State under what circumstances the sphere will slide without rolling, roll without sliding, and neither roll nor slide.

25. Proposed by Professor GEORGE LILLEY, LL. D., Ex-President of Washington State Agricultural College and School of Science, Portland, Oregon.

It is known that if the velocity of a certain freight train is 30 miles an hour it can be brought to a stand still in a distance of 500 feet by setting the brakes. It was stopped in 1200 feet by setting the brakes. Find its velocity, the forces exerted by the brakes being the same in each case.